

Armed Forces College of Medicine AFCM



Physiology of adrenal glands (2) By

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INTENDED LEARNING OBJECTIVES (ILO)



- By the end of this lecture (2), the student will be able to:
- 1. Mention the physiological actions of cortisol hormone.
- 2. Explain the diabetogenic effect of cortisol.
- 3. Summarize the control system for cortisol.
- 4. List the hormones that are released during stress.
- 5. Explain the manifestations of over-secretion of glucocorticoids.

Glucoocorticoids



(Cortisol)

They are essential for life.

1- Site of release:

- They are secreted by the zona fasciculata of adrenal cortex.
- Cortisol is the most potent & main GC (> 95%). (corticosterone also is secreted).

2- Nature:

- It is a steroid hormone.
- **3- Normal level:** 13.5 μg/dL
- 4- Mechanism of action:steroid hr.....

5- Physiological actions:

1- On metabolism:

Program

- On carbohydrate metabolism.
 - (+) of **gluconeogenesis** by the liver hepatic glucose output.
 - ↓ glucose utilization of by muscle & adipose tissue (anti-insulin effect).

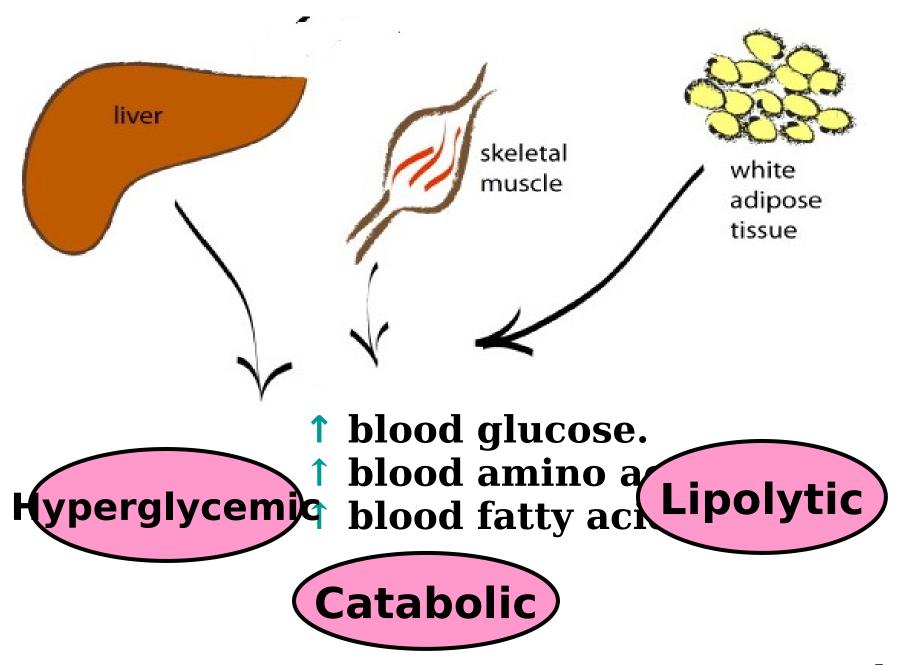
- Both effects [] 1 in blood glucose level [] adrenal diabetes.
- So cortisol is HYPERGLYCEMIC hormone.

On protein metabolism:

- <u>Extrahepatic</u> protein catabolism (e.g muscles, bone matrix, lymphoid tissue, skin).
- So, cortisol is a **CATABOLIC** hormone.

On fat metabolism:

- Cortisol (+) lipolysis by (+) of HSL.
 - mobilization of fatty acids from adipose tissue & their oxidation to be used as alternative fuel so sparing glucose for the brain.
 - provide glycerol to the liver for gluconeogensis.
- So, cortisol is a LIPOLYTIC hormone.



2- Permissive action:

Small amounts of cortisol must be present to allow some actions of other hormones to reach their full effect.

e.g.

- Cortisol permit the catecholamines to induce vasoconstriction, <u>liypolysis</u> and <u>bronchodilation</u>.
- The permissive effect of cortisol is also needed for glucagon to produce its <u>lipolytic</u> effect.

So, cortisol is needed for some actions of catecholamines and glucagon.

3- On C.N.S:

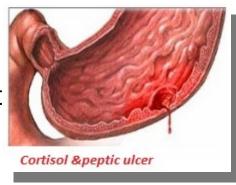
- Maintains normal neuronal excitability
- ↑↑↑ □ euphoria.

4- On C.V.S:

- sensitivity of vascular smooth muscles to catecholamines.
- **↑↑↑ | ↑ arterial blood pressure.**

5- On GIT:

- ↓ mucosal cell proliferation & mucous secret
- ↑ gastric acid secretion
 - **□** peptic ulcer.



6- On Kidney:

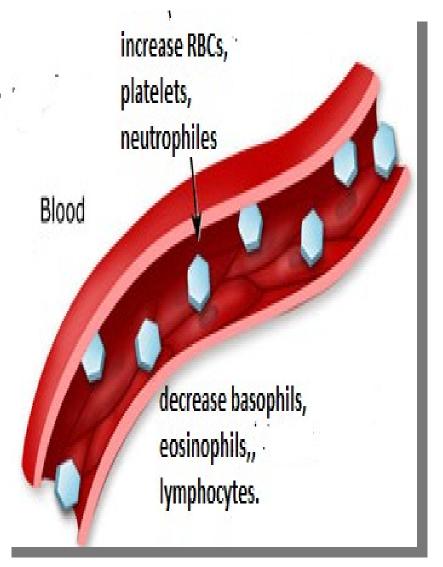
- ↑GFR. **}** ∏ Diuresis
- **↑↑↑ Slight mineralocorticoid like action** ☐ salt & water

retention New Five Year Program

7- On blood cells:

(depression of immunity,

- RBCs, platelets, neutrophils
- Basophils,
 Eosinophils &
 Lymphocytes.



8- On bone: over long periods

 ↓ bone formation & ↑ bone resorption [] osteoporosis.

Why??

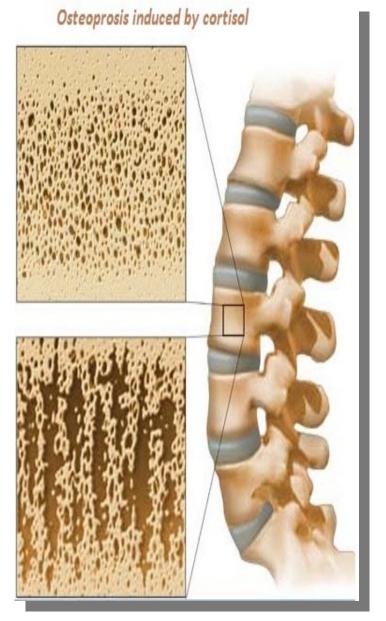
- **1-** ↓ protein synthesis by osteoblasts (catabolic) □ ↓ bone formation.
- 2- ↓ intestinal Ca++, PO4 absorption = anti-vit.D3. and ↑ renal excretion of Ca++, PO4.

Preme resorption.

□ ↓ plasma Ca++.



Endocrine & Genitourinary Module

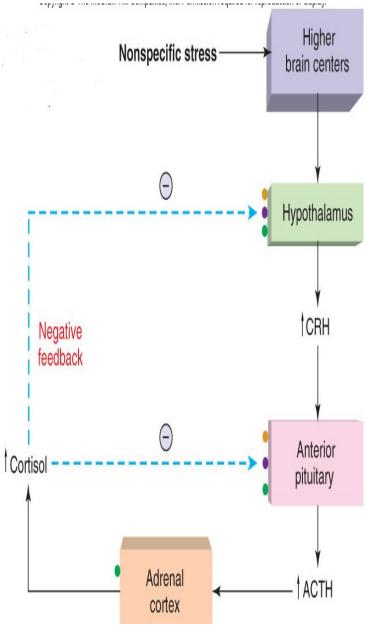


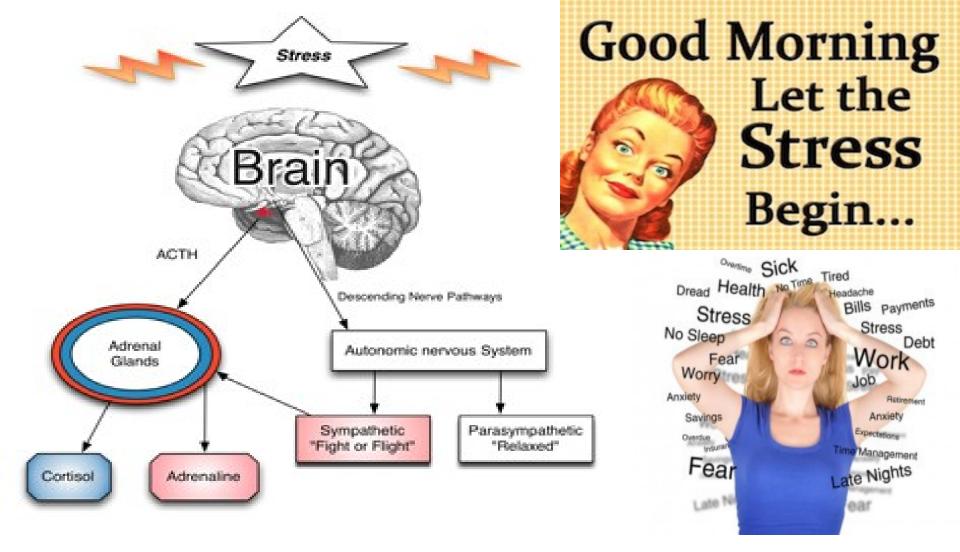
9- Adaptation to stress:

Almost any type of stress (physical or neurogenic) leads to 1 in cortisol secretion.

- □↑CRH.
- ☐ ↑ ACTH secretion.
- ☐ ↑ cortisol secretion.

This increase is essential for survival.

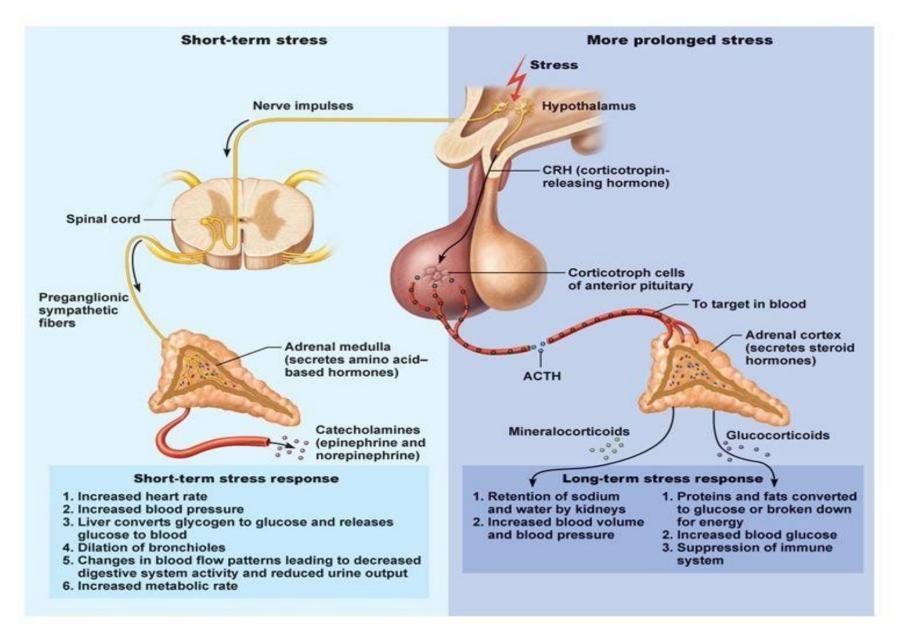




Why cortisol is needed during stress?

Its **metabolic** effects and **permissive** actions on catecholamines help to resist stress

Function of cortisol in stress



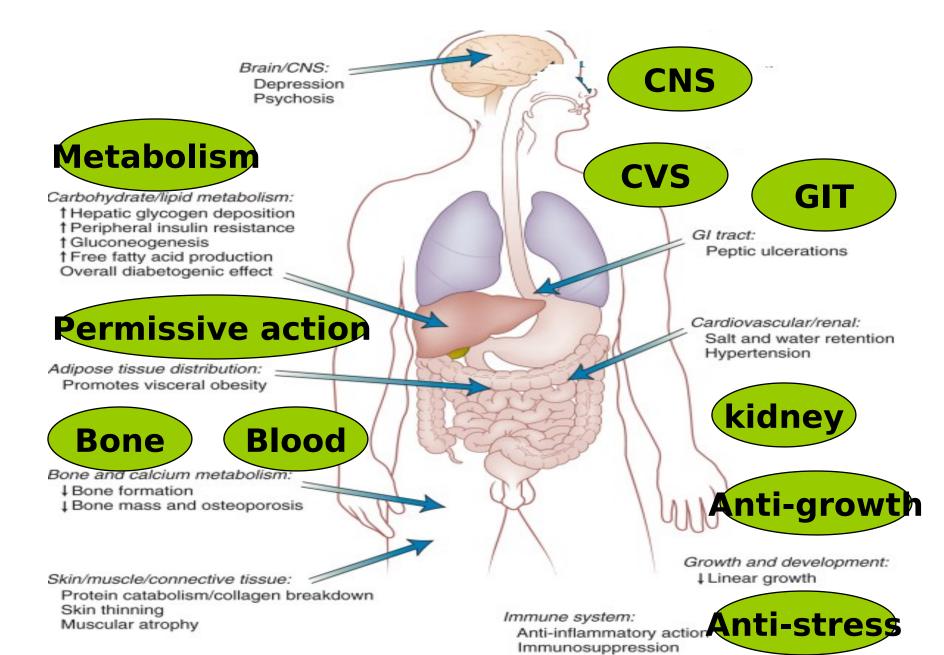
10- On growth & development:

= Antigrowth effects

Suppress growth hormone.



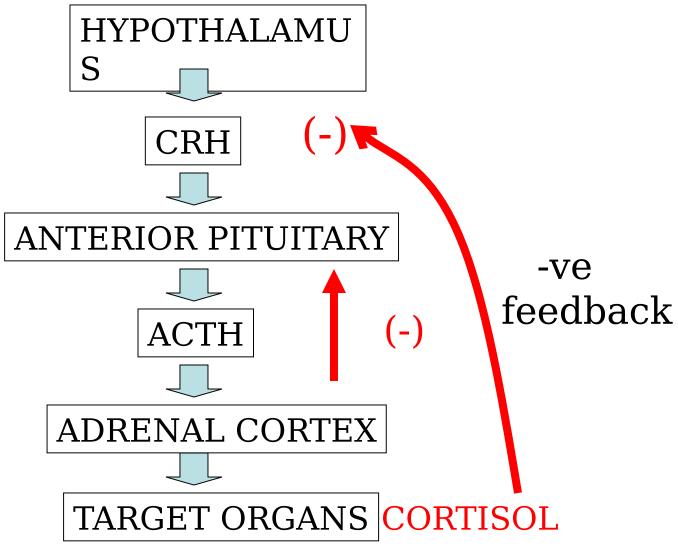
Anti vitamin D (antagonizes the effect of vit D on Ca++ & P absorption from intestine).



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REGULATION OF CORTISOL SECRETION



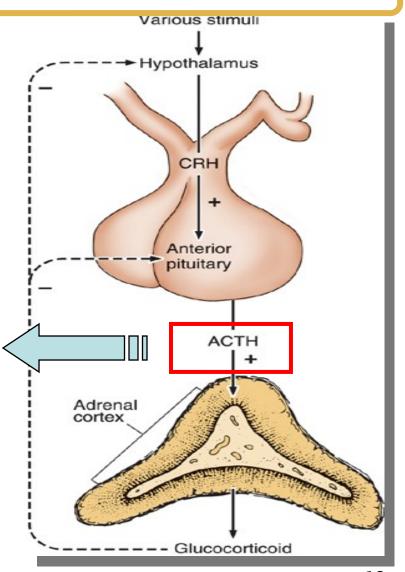


REGULATION OF CORTISOL SECRETION

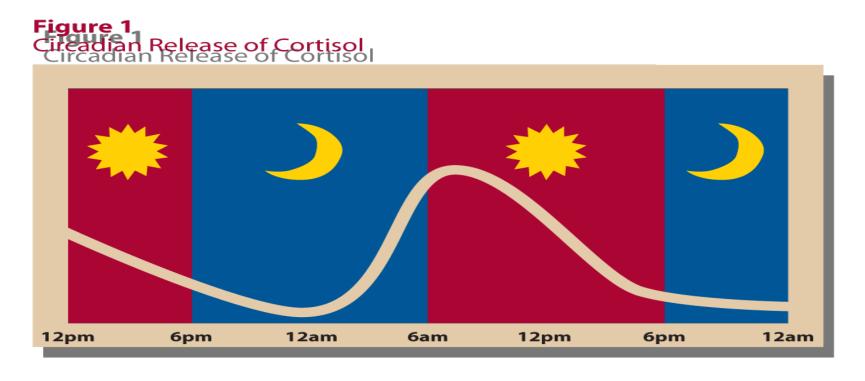


Actions of ACTH:

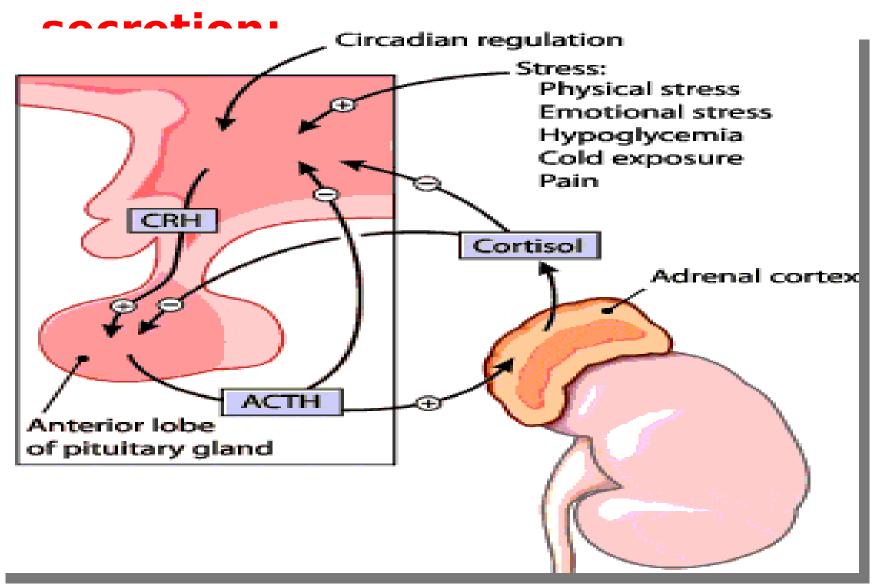
- 1- 1 Size & vascularity of gland.
- 2- (+) cortisol secretion by Z.F.
- 3- (+) androgen secretion by Z.R.
- 4- Minimal effect on Z.G.
- 5- MSH like activity [] skin pigmentation.



• Circadian rhythm: = Typical changes in plasma cortisol level that occur over a 24hour period with the highest level at the time of awaking <u>in early morning</u> and is lowest <u>in the mid-night.</u>



Stress induced cortisol

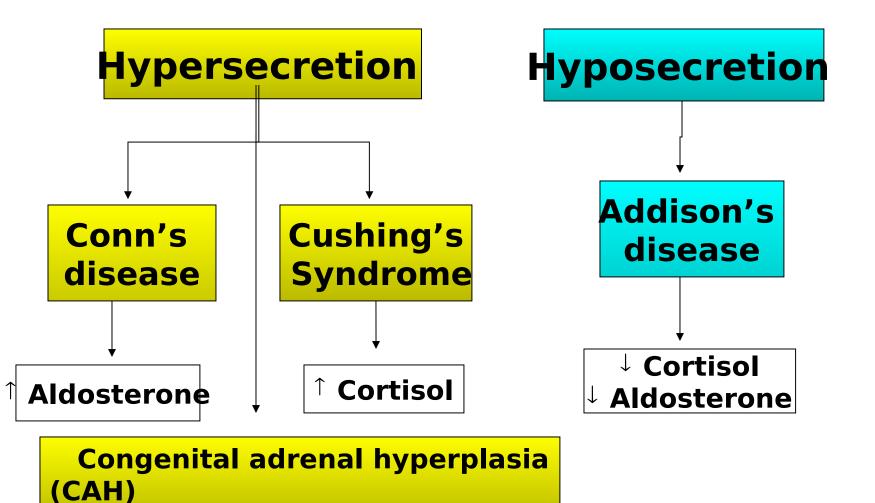


✓ Hormones released during stress:

- 1- **Glucocorticoids:** Almost any type of stress, whether physical or neurogenic, causes an immediate and marked increase in ACTH secretion by the anterior pituitary gland, followed within minutes by greatly increased cortisol secretion.
- Some of the different types of stress that increase cortisol release are trauma of almost any type, infection, surgery.
- 2- Mineralocorticoids: are said to be the acute "lifesaving" portion of the adrenocortical hormones, allowing the person to resist the destructive effects of life's intermittent physical and mental "stresses,"
- 3- Catecholamines are equally necessary. See later Endocrine & Genitourinary Module
- 1. Wasanressin also increases during stress

Disorders of Adrenal Cortex





bdule

=Adrenogenital syndrome

T sex hormones)

CUSHING'S SYNDROME



(TOO MUCH CORTISOL!)

- ecretion of cortisol from adrenal cortex (z. fasiculata).
- May be accompanied by excess secretion of androgen.
- More frequent in females at age of 30-50.

CAUSES:

- 1- non ACTH dependent Cushing Syndrome:
- Adrenocortical tumours (adenoma in Z.F)
 - Cortisol with subsequent suppression of ACTH.
- Prolonged glucocorticoid therapy as in patients with bronchial asthma or rheumatoid artharitis.

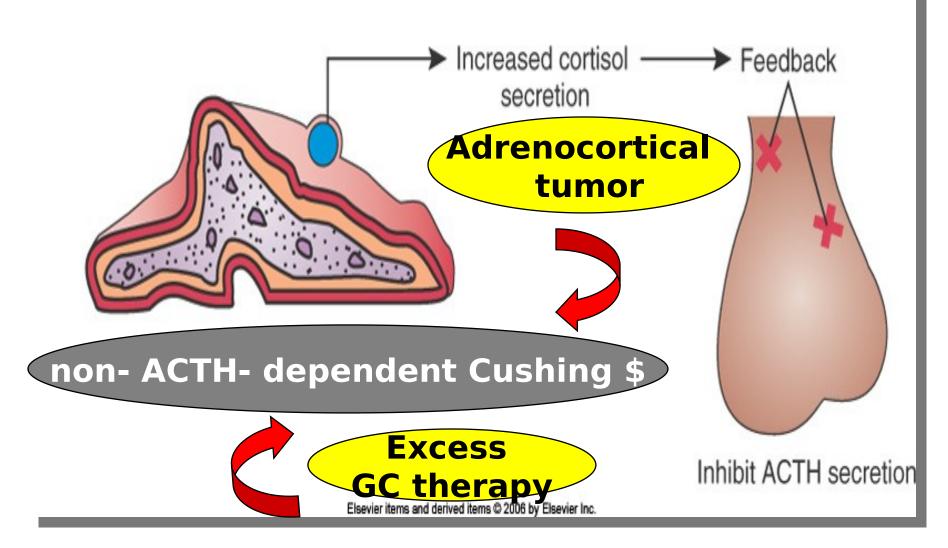
So, [] cortisol []↓ ACTH

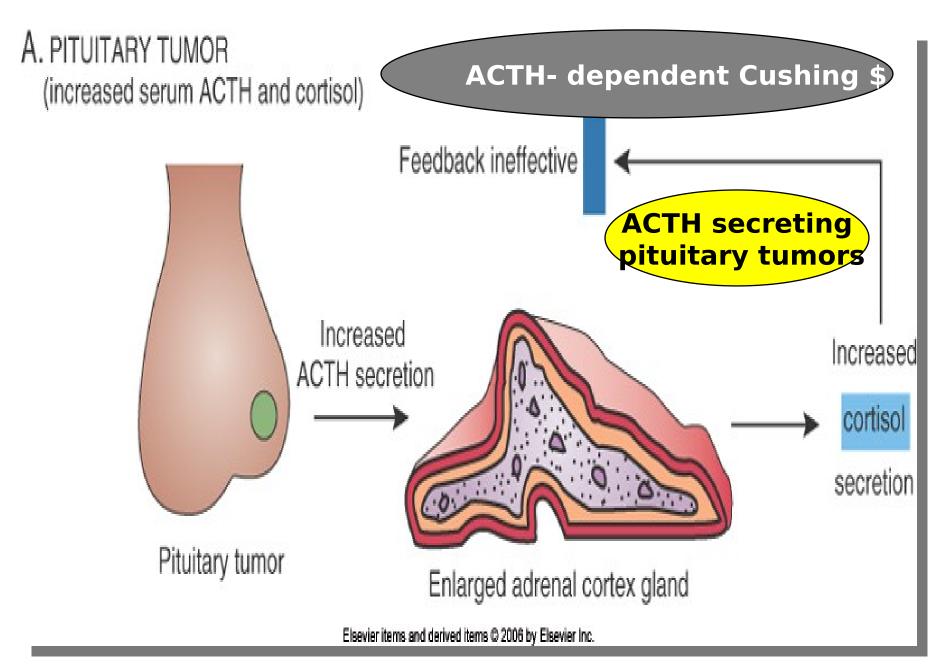
2- ACTH dependent Cushing Syndrome:

- ACTH secreting tumor in anterior pituitary
 - cortisol from adrenal cortex.

B. ADRENAL CORTEX TUMOR

(increased serum cortisol, decreased ACTH)



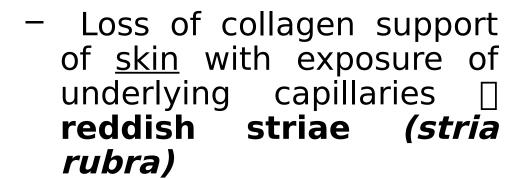


SIGNS & SYMPTOMS:

Protein catabolism:

Program

Wasting of muscles of arms & legs with muscle weakness.



Delayed & poor wound healing.
 New Five Year

Endocrine & Genitouring





Disturbances in fat metabolism:

Redistribution of fat & its deposition in abnormal sites.

- Face [] rounded , red with drooping of angle of mouth "moon face"
- Trunk & abdomen " trunkal obesity"
- Back of neck & interscapular region "buffalo hump".
- Lemon over watermelon over matchsticks.

Himprolycomia Dadronal diahotoc

Disturbances in CHO metabolism:

Endocrine & Genitourinary Module







- C.N.S: Depression, insomnia.
- C.V.S: Hypertension. How???
- GIT:

 Liability for peptic ulcer.

Kidney:

- Mineralocorticoid activity
- Salt & water retention []
 hypertension.

Blood:

- Polycythemia ☐ facial plethora.
- Immune suppression \square risk of infection.

Androgen secretion

- Excessive hair growth (hirsutism).
- Acne.

Program

Change in voice.

Personality Changes Moon Face. ↑ Susceptibility NA & Fluid Retention Males: Gvnecomasti Extremities Fat Deposits on Face and Back of Shoulders GI Distress - TAcid Amenorrhea, Hirsutism -Thin Skin Bruises & Petechiae 155 @2007 Nursina Education Consultants, Inc.

CUSHING'S SYNDROME









Treatment:

Surgical removal of tumour or discontinuation of the drug

Lecture Quiz



Q. Which of the following describes cortisol?

- a. inhibits the release of adrenocorticotropic hormone (ACTH) from anterior pituitary.
- b. is released with a circadian rhythm so that its blood levels peak at midnight.
- c. in normal physiological blood levels has an antiinflammatory effect.
- d. increases bone strength.
- e. decreases blood glucose level during fasting.

Lecture Quiz



Q. Which of the following describes Cushing syndrome?

- a. Occurs due to excess secretion of thyroid hormone.
- b. Associated with deposition of fat in face, chest and trunk.
- c. Associated with excess calcium deposition in bones.
- d. Characterized by severe hypoglycemia.
- e. Associated with increased immunity.

